Homework #8 – Due 4/1 beginning of class

If you have any questions about the homework, feel free to email me: sawtelle@umd.edu

1) **Reconciling Rules**
Wow! We have a made a ton of progress on sinking & floating in the last few weeks! Here I want to recap some of the rules we've made so far to get us all on the same page (notice I'm starting at #4 because #'s 1, 2, & 3 were on HW #7). We added a rule that defined how we measure pressure:

4. **We can measure pressure using the volume of the water displaced ($V_{water\ displaced}$), the weight of the water displaced ($W_{water\ displaced}$), the change in the scale reading (ΔSR), or the volume of the object that is under water ($V_{object\ under\ water}$), regardless of whether the volume naturally sank or floated.**

We had two rules that told us how we could tell if a given object would sink or float:

5. **(a) An object will <u>sink</u> if the weight of the object is greater than the weight of the water displaced ($W_{obj}>W_{water\ displaced}$).**
(b) An object will <u>float</u> if the weight of the object is equal to the weight of the water displaced ($W_{obj}=W_{water\ displaced}$)

6. **(a) An object will <u>sink</u> if the weight of the object is greater than the volume of the object ($W_{obj}>V_{obj}$)**
(b) An object will <u>float</u> if the weight of the object is less than the volume of the object ($W_{obj}<V_{obj}$)

And a proposed rule that people would like to test more that connected our experiments with the boats from a couple of weeks ago to the scale reading experiments:

7. **Water pressure (measured by ΔSR) depends on the surface area of the boat.**

This essay has two parts. In part 1, I want you to focus on rules 5 & 6. Kristen & Sam raised an important question wondering whether both of these rules could really be true at the same time. Sam's main objection (I think) focused on the idea we've been using repeatedly which says the volume of the object is equal to the volume of the water displaced, which is equal to the volume of the object ($V_{object} = V_{water\ displaced} = W_{water\ displaced}$), which says both of these rules cannot be true. So in this essay I'd like for you to think about this question. Can rules 5 & 6 both be true at the same time? If your answer is yes then I'd like you to explain how you see them as reconcilable – show me in a careful way how they make sense together. If your answer is no then I'd like you to explain what makes them incompatible – how would you change one of the rules to be compatible with the other?

In part 2, I want you to address Scott's question about rule #6 - what would happen if the volume of the object was equal to the weight of the object ($W_{object} = V_{object}$). What do you think would happen? Some people suggested tests that they did to support their answer, see if you have any evidence to support your answer as well.

2) Which direction does water push?

This week in class one group wanted to investigate how a boat filled with water would change the scale readings as the boat was submerged. They started by measuring the empty boat and found the SR = 70g out of the water. They then measured the boat filled with water and found the SR = 110g out of the water. But when they put the boat in the water (completely submerged at the same depth) they found that the scale reading was exactly the same for both boats (SR = 46g). They tried to decide how to explain the same scale reading and this is what two different students said:

> **Student A:** The water pressure underneath the boat is the only thing that determines water pressure. Since both boats have the same amount of water underneath, then they have the same scale reading.
>
> **Student B:** The water above the boat pushing down and the water below the boat is pushing up contribute to the water pressure. Since there is the same amount of water above and below both boats, they still have the same scale reading.

In this essay I would like you to consider the explanations from both student A & B in explaining the results of the U.S.S. Scorpion. This submarine imploded when it went below its collapse-depth in the ocean[1]. The picture below is an image of a section of the hull. Notice the shape the hull?

I know this can be a bit difficult to see, so I'm including this image of a soda can which looks remarkably similar to the image of the submarine.

In this question I'd like you to try and use Student A **AND** Student B's explanations to explain the shape of USS Scorpion after it went too deep in the ocean. Do both of them work equally as well to explain what we see? Does one work better?

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[1] You can find out more about the USS Scorpion here: http://www.nationalgeographic.com/k19/disasters_detail1.html

3) The meaningfulness of units

Physicists, and I consider myself one in this respect, love to use units to help them understand and explain ideas. In class this week I kept going on about comparing "coffee cups" to "rulers" or something like that when people were talking about comparing milliliters (mL) to grams (g). Particularly I kept pushing people to compare the same kind of measurements (so the weight of the water displaced compared to the weight of the object OR the volume of the water displaced compared to the volume of the object). Why do you think this is so important? Do you think I'm being overly picky? Similarly, we've had this question of whether we can measure pressure in grams. Using your own reasoning – what do you think? Is it OK to measure pressure in grams? Why or why not?